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through the researches of physical chemistry. Both Meyer and Ostwald have expressed their presentiment as to its existence, and the latter has said that if the properties of elements are found to be functions of atomic weights, we are impelled to seek in the latter the cause of the former, and so the notion of a homogeneous primitive matter whose different agglomerated states make up the differences of the elements is readily suggested. He admits that the hypotheses underlying this suggestion are not perfectly established, but the whole corresponds to the present endeavor of science to derive all differences from a fundamental underlying unity. The same problem has occupied Dr. Keller, but where Ostwald has approached it from considerations touching the causes of the periodic law, and from Prout's hypothesis, Dr. Keller has emphasised a different factor which he believes has never been cited in support of a probable existence of a homogeneous primitive matter, namely, the law of Dulong and Petit. It is beyond our purpose here to refer to more than the philosophical trend of Dr. Keller's little paper. The treatment is mathematical and will appeal to specialists only. The author is inclined to the opinion that the universal ether and primitive matter are the same, the universal ether being uncondensed primitive matter and constituting the bond which links the earth to the sun, etc.

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THE PHASE RULE. By *Wilder D. Bancroft*. Large 8vo, viii+255 pages. The Journal of Physical Chemistry : Ithaca, New York. Price, \$3.00.

In the last ten years great advances have been made in that part of science which applies physical methods to the elucidation of chemical problems. While the most brilliant achievements cluster about the "Theory of Solutions," the "Dissociation Hypothesis," and the molecular structure of liquids, important results have been obtained by the use of Gibb's Phase Rule and Le Chatelier's Theorem.

By a "phase" is meant a portion of matter that is chemically as well as physically homogeneous, and the Phase Rule states that the maximum number of phases possible in any given system is two more than the number of components, a component being defined as a substance of independently variable concentration. The Phase Rule having reference only to states of equilibrium, in case any alteration in a system supervenes and we want to know its direction, we have recourse to Le Chatelier's Theorem, which says that changes in the factors of equilibrium (temperature, pressure) due to external influences bring about reverse changes within the system.

The book before us is an attempt to treat the subject of qualitative equilibrium by the application of the Phase Rule and Le Chatelier's Theorem. Mathematical developments are excluded, probably with a view towards rendering the work the more acceptable to general chemists, most of whom have but a meagre mathematical equipment; graphical representations are, however, used in profusion.

After defining terms in the first chapter, the author passes to the consideration of systems made up of one component and hence presenting in maximo three

phases, solid, liquid, gaseous. Then systems containing two and three components are taken up and classified and treated according to the nature of the phases. Systems consisting of more than three components having as yet received but little experimental attention, the general theory of systems of four components together with such data as are at hand is given in the concluding chapter.

The author is full of enthusiasm for his subject, and has collected together about all that has been done along this line. Nevertheless, in some of his criticisms and discussions we might wish for greater breadth of view, and in certain points that are original with himself, more clearness.

All in all, the book is to be welcomed as a valuable aid in the study of the phenomena lying between the domains of Physics and Chemistry, and the reader will find in it novel and striking ideas about many things often regarded as trite and common. One point is especially worthy of note. Although the subject-matter pertains to chemistry and physics, nothing is said about atoms or molecules; the treatment is general and quite free from such suppositions the usefulness of which we are beginning to suspect we have in a measure outlived.

C. E. L.

**GRUNDZÜGE EINER THERMODYNAMISCHEN THEORIE ELEKTROCHEMISCHER KRÄFTE.**

By Dr. Alfred H. Bucherer. Freiberg: Craz & Gerlach (Joh. Stettner). 1897. Pages, 144. Price, M. 4.

This little book is in main a criticism of the electrolytic dissociation theory by Arrhenius, and Nernst's theory of electromotive force; it also contains some animadversions on the modern theories of solutions.

The author has had great difficulty, he says, in getting a clear conception of the nature of ions, and thinks that "those phenomena, to which Arrhenius's theory "owes its origin, that is, abnormal lowering of freezing point and abnormal osmotic "pressures, find a more natural explanation in the assumption of an association of "the dissolved substance with the solvent." This hypothesis of association is virtually a modification of the "Hydrate Theory."

The first three chapters of the book are devoted to the consideration of the Law of the Conservation of Energy and the Fundamental Principles of Thermodynamics. Emphasis is laid on the division of energy into two factors,—the intensity and the capacity factor.

A brief exposition of the ways in which thermodynamics is applied to electrochemistry, and of the various views on the nature of electrolytic conductivity leads up to the criticism of the recent views on these subjects and of the equations established by Nernst permitting of the calculation of electromotive force from data on temperature, osmotic pressure, and tension of solution. Now it must be admitted by even the most ardent partisan of these modern theories that there are some things about them that need clearing up; and whether we think the author has helped matters much or not, he will by his attack on their weak points at least have called the attention of others to them, and so assisted in their elucidation.